Advanced Fuel Cycle Initiative

Office of Nuclear Energy, Science and Technology
U.S. Department of Energy

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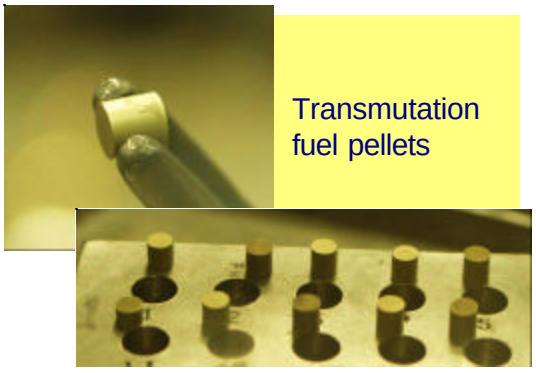
Background

The *National Energy Policy* (NEP) recommends that the United States "develop reprocessing and fuel treatment technologies that are cleaner, more efficient, less waste-intensive, and more proliferation-resistant." These technologies are key components of advanced nuclear fuel cycles that will be needed for next-generation nuclear energy systems. As identified in *A Technology Roadmap for Generation IV Nuclear Energy Systems*, six advanced reactor designs that offer the promise of commercial deployment after 2010 and before 2030 are under development by the U.S.-led Generation IV International Forum. These advanced technologies would use fuel and fuel cycles that are significantly different from those used by existing U.S. reactors.

The fuel treatment technologies under development in support of next-generation reactors also have potential for nearer-term application to optimize the capacity and performance of a geologic repository. Recycling, fuel treatment, conditioning, and transmutation technologies have the potential to dramatically reduce the quantity and toxicity of waste requiring geologic disposal. These technologies are not alternatives to a geologic repository but could help reduce the cost and optimize the use of a geologic repository as envisioned in the NEP.

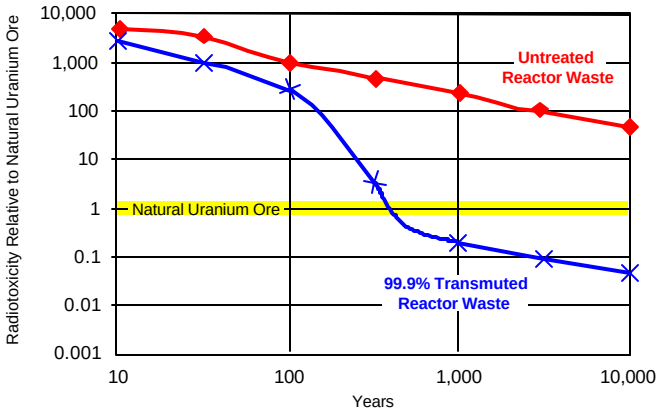


Mission

The mission of the Advanced Fuel Cycle Initiative (AFCI) is to develop fuel cycle technologies that will meet the need for economic and sustained nuclear energy production while satisfying requirements for a controlled, proliferation-resistant nuclear materials management system. AFCI is designed to develop these new technologies so that they may be deployed to support the operation of current nuclear power plants, Generation III+ advanced light water reactors, and Generation IV advanced reactors in order to achieve a significant reduction in the amount of high-level radioactive waste requiring geologic disposal, to reduce significantly accumulated plutonium in civilian spent fuel, and to extract more useful energy from nuclear fuel.

AFCI's primary near-term goal has been to develop and demonstrate advanced, proliferation-resistant fuel cycle technologies for treatment of commercial light water reactor spent fuel, to develop an integrated spent fuel recycling plan, and support a recommendation by the Secretary of Energy regarding the need for an additional geologic repository. Current legislation requires the Secretary to make a recommendation to Congress regarding the need for a second repository as early as January 1, 2007, but before January 1, 2010. AFCI provides spent fuel treatment technologies to support an expanding role for nuclear power in the United States.

In the longer term, AFCI's development of a system involving spent-fuel partitioning and recycling of actinides and other long-lived radioactive components in fast reactors for destruction through transmutation could result in a de facto fifty-fold increase in the technical capacity of the planned Yucca Mountain repository. This increase would come principally from the destruction of highly-radioactive materials contained in spent fuel (actinides) that



With transmutation, used fuel radiotoxicity is reduced to that of the source uranium ore within a few centuries

generate the heat that limits repository capacity. Such a capacity increase would be more than enough to accommodate all the spent fuel generated in the U.S. this century from any conceivable nuclear energy deployment scenario.

Research and Development

Over the near term, the AFCI program will conduct research and demonstrate technologies that have a high probability to reduce the volume and near-term heat generation of spent nuclear fuel waste requiring repository disposal. The AFCI program, in cooperation with the Department's Office of Civilian Radioactive Waste Management (RW) and international partners, is developing proliferation-resistant separations processes for the treatment of used nuclear fuel from current light water reactor and advanced light water reactor systems. While plutonium burning and transmutation of some of the other transuranic elements that impact repository performance can be accomplished in thermal reactors, more complete transmutation of transuranic elements is achievable in fast reactors with a much larger improvement in repository performance as a result. The AFCI program will develop advanced fuels and associated reprocessing technologies for sodium-cooled fast reactors to enable the energy value of spent fuel to be recovered, while destroying the contained transuranics.

FY 2006 Planned Accomplishments

- Begin the scale-up of hot laboratory testing of aqueous chemical separation of light water reactor spent fuel to an engineering-scale. Initiate conceptual design of an engineering-scale demonstration experiment.
- Complete an inert matrix fuel irradiation test in the Advanced Test Reactor and complete post-irradiation examination on high-burnup transmutation fuels.
- Complete preconceptual design and initiate conceptual design of an Advanced Fuel Cycle Facility with capability to perform R&D, lab-scale and engineering-scale tests of advanced separations and transmutation fuels technologies.

FY 2007 Planned Accomplishments

- Complete research and development activities that allow the AFCI program to support the Secretary of Energy's determination of the need for a second geologic repository for used nuclear fuel by FY 2008.
- Select a preferred technology for partitioning commercial light water reactor spent fuel.
- Complete conceptual design of the Engineering-Scale Demonstration and the Advanced Fuel Cycle Facility, and issue report.

Program Budget
AFCI
($ in Millions)

FY 2006	FY 2007
Adj. Approp.	Request
$79.2	$243.0